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THE IMPLEMENTATION OF PLANS FOR THE DEVELOPMENT OF THE CHEMICAL INDUSTRY

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The Implementation of Plans for the Development of the Chemical Industry

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1. To the people of the underdeveloped countries the establishment of a chemical industry represents making available many of those products and services which are already an essential part of the life of more privileged countries. Plastics, man-made fibres, paints, suface coatings, fertilisers, insecticides, pharmaceuticals, detergents, inorganic and organic chemicals - the range of products of the chemical industry is now immense and permeates every phase of our daily lives.

2. Looking at the benefits which a developed chemical industry can provide, the underdeveloped country may take a decision in principle to further the establishment of its own chemical industry. But how is such a decision to be put into effect ?

3. Scarcity of technical personnel in the underdeveloped countires, and even in the entire world, familiar with the complex technical considerations in the rational and economic choice of plants over the whole field of the chemical industry immediately presents a severe restriction. Economic factors are obviously of the highest importance. To operate profitably, modern chemical plants must in general be large. The purchasing power per capita in many of the underdeveloped countries is low and careful attention must be given to the problem of determining how the production may be absorbed. Nor must it be forgotten in this connection that considerable extra investment is required in subsidiary industries for dealing with the finished products from the chemical industry. In the plastics industry for example, may be cited the film making, extrusion and moulding machinery necessary for converting plastics into saleable articles. Finally, the social impact of a chemical industry must be examined. However, there is no doubt that chemical plants which represent an intense concentration of capital and technical skill cannot act otherwise than as foci for the development of technical and managerial skills with resulting benefit to the country as a whole.

4. A country without any chemical industry whatsoever is rare. But in a country where only a few chemical plants exist, these have usually been built as a result of local considerations without relation to the national economy as a whole. This paper begins from the point of view of a country with a limited chemical industry and the suggested steps which may be followed towards the creation of a chemical industry. It attempts to outline the factors which are of importance in considering the problem as a whole. Some of the latter considerations may be of interest to those countries which have already reached an advanced stage in the planning of their chemical industry. This paper therefore begins with a suggested type of initial survey which can be carried out as a first step in implementing a decision to develop a chemical industry.

5. The purpose of the initial survey should be to establish the outlines of the most economic and beneficial future pattern which a chemical industry could follow. Before such a survey can be effectively undertaken, certain basic information must be made available in as much detail as possible. This information may be briefly summarized as follows :

(a) Meteorological conditions :

i) Rainfall statistics.
ii) Temperature statistics.
iii) Wind conditions.

(b) Hydrological survey :

(i) Main rivers - monthly flow - temperature conditions, and purity of water
(ii) Other water sources

(c) Topographical information

(d) Transport facilities :

(i) Ports - location - tonnage handled - lifting facilities
(ii) Railways - location - load capacity - cost of transport per ton/mile
(iii) Roads - location - cost of transport per ton/mile

(e) Consumption of chemicals

(f) Existing chemical plants :

(i) Location and type
(ii) Products - quality and quantity
(iii) Raw materials

(g) Existing industrial plants :

(i) Location and type
(ii) Products - quality and quantity
(iii) Raw materials

(h) Geological conditions :

(i) Mineral deposits
(ii) Coal deposits
(iii) Oil or natural gas fields

(j) Existing electrical power system

(k) Customs dues and regulations

(l) Fiscal policy

(m) Internal costs, such as :

(i) Wage rates
(ii) Cost of common products, e.g. gasoline, fuel oil, etc.

6. As part of their development programmes, most countries have already set up departments or institutes in the meteorological, hydrological and geological fields. Turkey is an example where information of this type is particularly well documented. Information on transport facilities is, as a rule, readily available. Again, information on the existing electrical power system, customs dues and regulations, and fiscal policy can be obtained from the respective Ministries.

7. For the following categories : existing chemical plants, existing industrial plants, and consumption of chemicals, it is often more difficult to obtain precise information. Customs' statistics are generally unreliable sources of the consumption of chemicals because of the grouping of certain classes of chemicals and re-exports. The best guide is often direct contact with the existing industries themselves, which can be carried out in conjunction with the initial survey. In such a way a more realistic estimate of present and future consumption can be made and the initial survey can use the experience, even if limited, of the organizations already operating.

8. Notwithstanding the aims of the survey itself, the ready availability and careful documentation of the information of the categories listed above is an important factor in establishing confidence with private companies which will later consider establishing plants in the country.

9. There is a wide choice of organizations capable of carrying out such a study. However, under present-day conditions, one important factor must be taken into account. The chemical processes developed by the chemical companies are either licensed directly to other chemical companies or through the international chemical engineering contractors. It is only these latter organisations, together with the chemical companies themselves that have reliable technical and financial data over the whole field of the chemical industry. Many published data exist, but again the sifting of the accurate from the erroneous information demands a wide background of experience. Apart from these companies, only Government or International Agencies may, in general, succeed in obtaining the necessary access to the experience and jealously guarded know-how of the chemical companies. This problem is a particularly stringent restriction on the activities of consulting firms and only the largest can hope to be in possession of the necessary facts for carrying out a survey of this type. A representative, but not necessarily complete, list of possible organizations is given in Table 1, with, in some cases, references to studies which have been carried out.

10. The cost of the initial survey should be approximately $5,000 to $40,000 and require that up to four technical experts visit the country for a period of one to four months. Following the visit, the compilation of the data and preparation of the report could last a further two to three months. Various International and Government Agencies will, in certain circumstances, offer financial assistance under their technical aid programmes towards carrying out this type of survey.

11. The final report should have basically the following contents :

(a) General survey of the country recording any particular difficulties;
(b) Market assessment of present and future chemical needs;
(c) Recommendations on the type of chemical plants which could be established, and suggested locations;
(d) Capital and operating costs for the plants proposed (a typical example is provided in Table 2);
(e) Recommendations on the programme for establishing the plants;
(f) Summary of basic data.

12. On the basis of the initial survey, the Government may decide the allocation of possible chemical projects to the public or private sectors. The wide circulation of initial survey among the international chemical companies and local investors can focus their attention on the investment possibilities. Together with the initial survey, information may be distributed on any financial incentives that the Government may wish to institute to further the attractiveness of the private companies' investment. Such incentives may be :

(a) Period of tax exemption;
(b) Rapid amortization of plant;

(c) Waiving import duty on the imported plant and equipment;
(d) Free transfer of profits and capital.

13. To handle the complex problems of implementing a programme for the development of chemical industry both in the private and public sectors, an efficient Government organisation is necessary. This organisation should have broad powers to cover :

(a) Research and development;
(b) Project studies;
(c) Promotion of the chemical industry;
(d) Preparation of invitations to tender for chemical plants in the public sector and their subsequent technical and commercial evaluation;
(e) Recommendations to the Government on price policy, tax considerations, etc., in relation to the chemical industry.

14. This paper is too short to contain a detailed examination of such an organisation. Advice may be obtained from many of the bodies listed in Table 1. Certain of these organisations, such as the Institut Francais du Petrole, have already developed programmes for assisting other countries in the establishment of institutes covering the technical aspects of the problem which could be later expanded to cover the above-mentioned requirements.

15. Before considering the next phase of the detailed survey and the subsequent preparation of invitations to tender, some understanding is necessary of the broad cost components of a chemical plant and their influence on the form of tender and the subsequent work. The cost of a chemical plant may be divided under the following headings :

(a) Royalty or licence fee;
(b) Engineering and drafting;
(c) Equipment and material;
(d) Transport of equipment and material to site;
(e) Erection labour, together with hire-purchase of construction equipment and contractor's supervision.

16. Table 4 shows the percentage breakdown of cost under these headings for a large nitrogenous fertiliser plant. Variations in these percentages naturally occur for different types of plant, but the order of magnitude in general remains the same, apart from plants of a capital investment of less than $500,000.

17. To a person unfamiliar with the industry, the percentage cost of engineering and drafting may appear high. However, each large chemical plant is unique and must be designed afresh in accordance with the overall and local conditions which are imposed. The preparation of the detailed drawings for each item of equipment and the piping connected with it, the engineering specifications, and the process calculations can involve an expenditure of from 10,000 to 250,000 man-hours, depending on the size of the plant.

18. In the programming of the plants to be built it must be taken into account that as a yardstick approximately two years are required to put into operation a large chemical plant, from the date of signature of the contract. Careful analysis must be made of the financial obligations throughout the design and construction period and also of the delivery and construction requirements in relation to transport and port facilities, availability of construction labour, etc. The graph of Table 5 shows the ideal progress of a project in terms of :

(a) Material and equipment commitment;
(b) Engineering and drafting man-hours;
(c) Construction man-hours.

19. In deciding the form of purchase of the plants, the customer has three main choices. These are shown in Table 3.

20. Purchasers in the West of considerable experience, such as the large oil and chemical companies, often choose the first alternative. The contractor can estimate his price generally within one month, and work can proceed immediately. Knowing the prevailing costs and being thoroughly familiar with the technical aspects of the work, the purchaser has considerable flexibility in altering the contractual or technical conditions.

21. The other countries of the World generally stipulate contracts of the form of Alternative II or III. For Alternative III, the preparation of the tender may require from two to six months. The investigation of the local conditions regarding the erection must be carried out in great detail since, as we have seen, the price component of Table 3, Erection Labour, etc., may be of the order of 25% of the total cost.

22. When the overall programme for the establishment of chemical plants has been agreed, the Government organization previously referred to may proceed to the detailed studies necessary to determine the basis on which these plants may be built. In the event that the technical resources of the Government organization are not sufficient to carry out these detailed studies, recourse may be made to the engineering contractors listed in Table I.

23. In using an engineering contractor, it may be expected that the detailed evaluation of one large chemical plant may cost from 1/8th to 1% of the erected capital cost. The detailed evaluation should make recommendations on the following points :

(a) The most suitable process according to the conditions;
(b) The most suitable location of the plant;
(c) The total capital and operating costs of the erected plant;
(d) The marketing of the products;
(e) The suitable contracting companies to which the invitation to tender should be issued.

24. Together with these recommendations, the detailed survey should re-compile all the essential information previously indicated under the initial survey in order that the contractor who submits the tender may have all the relevant information at his disposal. Following this work, preparation of invitations totender may be instituted. The main headings under the invitation to tender may be listed as :

(a) Technical specifications;
(b) Contractual conditions;
(c) Credit conditions.

25. After a detailed evaluation of a particular plant as suggested, there should be little difficulty in drawing up a suitable technical specification. However, care should be taken to see that the specification is as complete as possible in that most underdeveloped countries will select Alternative II or III of Table 3, in order to have a fixed definition of the cost and technical scope of the plant and to facilitate the comparison of the bids received. For this reason, the battery limits and scope of supply of the contractor must be carefully stipulated.

26. The requirements of the contractual conditions vary widely from one country to another. Theoretical and severe contractual conditions are liable to increase the cost of a chemical plant in order to enable the contractor to cover any unforeseen losses he may expect owing to their application. Much difficulty would be avoided if countries would use as a framework of their contractual conditions those established by The United Nations, which provide a fair basis for both parties.

27. The terms of credit are of great importance for many underdeveloped countries. A distinction should be drawn here between Government or semi-Government credit organizations, such as the Export-Import Bank, and the more normal credit terms insured by Government organizations, such as those offered by countries which are signatories to the Berne Convention. The terms offered by the Export-Import Bank, or similar institutions, are in general the most favourable which can be obtained. In the case of countries which are signatories to the Berne Convention, credit terms are normally limited to 10% on order, 10% on shipment, and 80% in five years from the mean date of shipment. Under these terms, considering normal tax and amortization arrangements, the capital involved is not paid off until six or seven years from the date of signature of the contract. Furthermore, a difficulty arises that these terms do not normally provide for any credit facilities for the local expenditure as under Alternative II of Table 3. Great assistance could be given by the more developed countries by reducing the payments required before the start-up of the plant and also by financing the local expenditure involved in the construction and other services which are required. While other credit terms offered may appear attractive, it should be noted that, if the contractor is required to make substantial modifications to the credit terms authorized under Government policy the cost of the credit may increase very steeply. This must be carefully evaluated against the benefits which such credit terms may provide.

28. The selection of the contractors who will be invited to tender must be made in accordance with the detailed evaluation which has been carried out taking into consideration the various contractors' ability on the basis of their technical experience and record in completing successfully a plant of the type which is required. As the bidding costs are high, it is equitable to make an initial selection of , say, between four to six experienced contractors, rather than to ask for free international competition. International competition may result in certain highly competent contractors refusing to quote because they consider their bidding expenses are not justified in relation to the probability of obtaining the contract. When the bids have been received, the evaluation of the respective technical and commercial merits of each bid is highly complicated. As the country concerned will probably have chosen either an Alternative of II or III, approximately as much work is required in the evaluation of the bid as in its preparation by the contractor. However, preliminary economic evaluation can be rapidly made in the following terms :

(a) Capacity, yield and purity of products;
(b) Capital cost of the plant;
(c) Utilities consumption;
(d) Delivery period.

29. Many of the Socialist countries insist that the tender includes a break-down of the price of equipment, together with the weights of each class of equipment. The weights of equipment can be used to determine immediately whether the contractors are bidding on approximately the same basis and further, can be used to check the rough price : weight ratios, to determine whether these fall within the range of world market prices. This procedure might be usefully followed by many underdeveloped countries.

30. Nothing would benefit and accelerate the evolution of the underdeveloped countries more than the establishment - where conditions permit - of chemical plants. Industry and agriculture, as well as the whole social and economic fabric of the country in general, can then reap the immense advantages which the chemical industry has to offer now and in the future.

TABLE I

1. International Organizations:

   (a) United Nations - Technical Assistance Administration [a]
   (b) Food and Agricultural Organization (F.A.O.) - Rome, Italy (restricted to fertiliser plants and agricultural chemicals)

2. Government Organizations:

   (a) Department of Scientific and Industrial Research (D.S.I.R.) - United Kingdom.
   (b) Office National Industriel de l'Azote (O.N.I.A.) - Toulouse, France (restricted to fertiliser plants).
   (c) Institut Francais du Petrole (I.F.P.) - Paris, France *.
   (d) Ente Nazionale Idrocarburi (E.N.I.) - Rome, Italy *.
   (e) National Research Council, Washington, U.S.A. [b] *.
   (f) The various Ministries of Chemical Industry, or associated agencies, of the Socialist countries, e.g. Limex Aussenhandelsgesellschaft mbH, German Democratic Republic.
   (g) Ministerio de Minas e Hidrocarburos - Instituo Venezolano de Petroquimica - Caracas, Venezuela.

   * The activities of these organizations cover the chemical as well as the petroleum industry.

3. International Oil and Chemical Companies:

   These are omitted as being well-known.

4. International Chemical Engineering Contractors:

   (a) United Kingdom

   (i) Humphreys & Glasgow Limited - London.
   (ii) The Power-Gas Corporation Limited, Stockton-on-Tees.
   (iii) Simon-Carves Limited, Stockport.

   (b) France

   (i) Technip (associated with Institut Francais du Petrole), Montrouge
   (ii) Societe de Construction d'Appareils pour Gaz a l'Eau Industriels (SEGI) Paris.

   (c) Italy

   (i) Compagnia Technica Industrie Petroli SpA (C.T.I.P.) - Rome.
   (ii) Societa Montecatini, Settore Progetti e Studi - Milan.
   (iii) SNAM Progetti - Milan (wholly owned subsidiary of Ente Nazionale Idrocarburi, Rome)

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a] Krijgsman, W. Technical Assistance Committee of the United Nations, Los Proyectos de Industria Petroquimica y Carboquimica en Chile, 15th March 1958

b] Academy of Sciences/National Research Council, Washington, D.C., Contract SCC 21718, Utilization of Waste Gases in Saudia Arabia, 14th July 1954.

(d) Federal Republic of Germany

(i) Lurgi Gesellschaft fur Warmetechnik mbH - Frankfurt.
(ii) Hoechst - Uhde International.
(iii) Platsch-Banag A.G., Butzbach/Hessen.
(iv) Hans J. Zimmer - Frankfurt.

(e) United States of America

(i) C.F. Braun & Company Limited, Alhambra, California.
(ii) Bechtel Corporation, San Francisco.
(iii) Foster Wheeler Corporation, New York.
(iv) Lummus Corporation, New York.
(v) M.W. Kellogg, New York.
(vi) Scientific Design Co. Inc., New York.
(vii) Stone & Webster Corporation, Boston.

(f) Belgium

(i) Union Chimique Belge S.A. - Brussels.

(g) Holland

(i) Stamicarbon N.V. - Geleen.

5. International Consultancy Firms :

(a) Arthur D. Little, Inc., Cambridge, Mass., U.S.A. [c]

TABLE 2

Cost of Production of Polyester Resins [d] 450 tons/year

1. Variable Costs		Costs in Chilean Pesos
a) Raw Materials		
Maleic anhydride	200 tons at 760 pesos/ton	152,000
Ethylene glycol	140 tons at 487 pesos/ton	70,000
Styrene monomer	150 tons at 350 pesos/ton	52,000
b) Utilities		
Carbon dioxide		300
Electricity	at 0.017 pesos/KWH	1,700
Steam	at 2.6 pesos/ton	300
Water	at 0.0122 pesos/m^3	700
Operating Labour	3 men/shift at 0.5 pesos/hour	12,000
Maintenance	2%	1,300
		290,800

c Little Inc., Arthur D. A Program for the Industrial and Regional Development of Peru. Report to the Government of Peru. 30th December 1960.

d Delorme, Jean, Technical Assistance Committee of the United Nations, Promocion de la Industria de Materias en Chile, 14 July 1961

2. Fixed Costs

Amortization :	equipment 10% of 53,000 pesos	5,300
	buildings 5% of 12,000 pesos	600
Indirect costs		7,000
Taxes, etc.		1,300
General costs		2,000
Interest at 10% on capital employed		5,500
		21,700
Total cost of producing 450 tons/year		313,500
Production cost/kg.	0.70 Pesos	

TABLE 3

		Alternative I Fixed Engineering Fee	Alternative II Engineering and Materials fob	Alternative III Turnkey
1.	Royalty or Licence Fee	Fixed	Fixed	Fixed
2.	Engineering and drafting	Fixed	Fixed	Fixed
3.	Equipment and material	Direct costs plus agreed percentage paid by client	Fixed	Fixed
4.	Transport of equipment and material to site	Costs paid by client	Costs paid by client	Fixed
5.	Erection labour together with hire/purchase of construction equipment and contractor's supervision	All costs paid by client. Weekly charge for contractor's supervising personnel	All costs paid by client. Weekly charge for contractor's supervising personnel	Fixed
		1 + 2 Fixed price 3 + 4 + 5 Variable as incurred	1 + 2 + 3 Fixed price 4 + 5 Variable as incurred	1 + 2 + 3 + 4 + 5 Fixed price

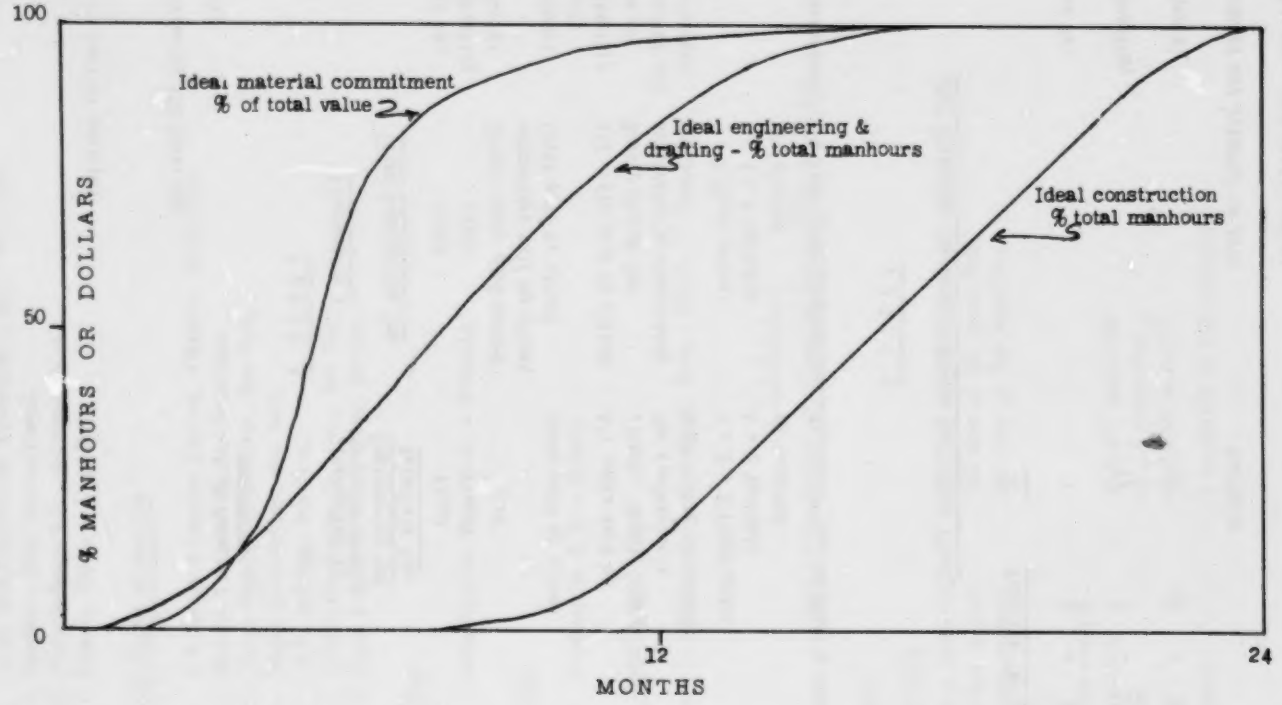
These are the main alternatives. Various other combinations can, of course, be readily seen.

TABLE 4

Cost Breakdown for Large Nitrogen Fertiliser Plant

		%	Possible Variations %
1.	Royalty or Licence Fee	1	0 - 5
2.	Engineering and Drafting	13	7 - 20
3.	Equipment and Material	61	45 - 70
4.	Transport of equipment and material to site	Variable	
5.	Erection labour together with hire/purchase of construction equipment and contractor's supervision	25	15 - 30
	Total erected cost ready for operation	$14,000,000	

TABLE 5



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